

the

CANNON

University of Toronto Engineering Society

SECOND ISSUE

October 5, 1978

High Octane Varsitys

SOLID WASTE MANAGEMENT



How Garbage Can Help Solve The Energy Crisis

Tim Taylor
4th Year Civil

Inspired by the energy crisis of the early seventies, a technological stampede to alternate sources of energy has brought us a veritable smorgasbord of viable means of reducing North America's dependence upon non-renewable fossil fuels.

One offspring from our energy-conscious society is a program to develop energy from urban solid waste. It has been estimated that the average American produces about .9 tonnes of solid waste per year (one can assume Canadian figures are of the same magnitude) and that this figure is growing at an annual rate of 5%. A city the size of Metro Toronto (population assumed to be 2½ million) would therefore produce 2,250,000 tonnes of refuse a year. If 50% of this waste is combustible (as estimated and verified by research at the University of Louisville) 1, then the potential exists for burning 1,125,000 tonnes of refuse each year. (The other 50% of the waste is composed of non-combustible materials such as metals and liquids.) Heat content of the waste varies but, as a general rule, two tonnes of refuse is equivalent to one tonne of average coal. Therefore, Toronto is producing the equivalent of 562,500 tonnes of coal per year which is not being used. At the present cost of \$37.70 per tonne of coal, which is the price Ontario Hydro is currently paying to fuel its generating stations, this is 21 million dollars worth of energy being dumped into Lake Ontario every year.

"Efforts to reclaim energy from solid wastes can be broadly classified into four distinct schemes: direct heat recovery from special incinerators, supplementary fuelling of power plants, destructive distillation (pyrolysis) and an adaptation of present technology to waste heat recovery."

WASTE INCINERATORS

Waste Incinerators are the most traditional and most widely developed method of reclaiming waste as a fuel. Many large incinerators have been built in North America and Europe to provide heat for steam plants, for the desalinating of sea water, and space-heating or air conditioning. These incinerators can be centrally located to receive refuse and distribute steam by a network of pipes similar to water mains.

The major problem with waste incinerators is the variable heat content which can be expected due to wide variation in moisture content of the waste. This forces the incinerator to use either supplementary fuels or guarantee a minimum output, resulting in a loss of economic advantage. (For example, an incinerator in the Netherlands — considered to be the most modern and sophisticated in the world — has a maximum capacity of 55 MW but the minimum guaranteed by contract is only 11 MW).

SUPPLEMENTS TO PRESENT FUELS

A process primarily

cont. on page 2

ENVIRONMENTAL IMPACT

Penquins Swim North

It has been thought for some time that the best way to understand the immediate environmental effects of a single meteorite impact would be to subject a large, well-exposed and reasonably accessible terrestrial crater to close scrutiny.

In many respects the Manicouagan impact crater in central Quebec is considered the ideal candidate for such a study.

Recent satellite observations of the Manicouagan region, made with the aid of the Skylab and Landsat imaging systems, have revealed the presence of an outer ring with a diameter of 150 kilometers, approximately twice that of the circular trough now filled by the reservoir. This multi-ring aspect of Manicouagan has been compared to the vast multi-ring basins observed on the moon and on Mercury. According to one interpretation, the outermost ring of 150 kilometers marks the limit of the disruption of the bedrock by the shock wave associated with the meteorite's impact, the innermost ring at 35 or 40 kilometers approximates the limit of the initial cavity ex-

cavated by the impact, and the intermediate ring at 65 or 70 kilometers indicates the apparent location of the rim of the crater before it was eroded.

For the past few years an interdisciplinary team of U.S. and Canadian investigators has been conducting detailed field studies of the Manicouagan site. Rock samples were collected at 27 cliff-side locations within the Manicouagan melt sheet, a 230-meter-thick annular plateau that surrounds the central peak of shocked, uplifted bedrock. More than 1,000 samples were collected, "resulting in 52 new chemical analyses of major and trace elements as well as several hundred thin sections for petrographic and microprobe analyses." From these data it is now possible to reconstruct the events that formed the Manicouagan structure.

The projectile responsible for the crater fell to the earth some 214 million years ago, striking a target of "relatively dry Precambrian metamorphic rocks overlain by a thin veneer of Ordovician limestone." The large amount of fused rock found at the site (estimated to be as much as 475 cubic kilometers) indicates that the

object "had a high velocity." Assuming that it was a stony meteorite travelling at a typical velocity of 17 kilometers per second, it must have been about eight kilometers across to have yielded the amount of energy needed to melt such a large volume of rock. The impact caused a high-pressure shock wave that propagated rapidly outward from the point of impact, excavating a transient crater between five and eight kilometers deep and between 30 and 44 kilometers across. This initial crater was formed in about five seconds.

cont. on page 3

THE CANDU ACHIEVEMENT

cont. from last issue.

Dr. G. A. Pon
Corporate Vice-President,
Engineering, Atomic Energy of
Canada Ltd.

WASTE MANAGEMENT

CANDU technology from its inception has been predicated on "once through" fuelling. Since the nuclear fuels used in other countries' systems con-

tain expensive enriched uranium, which is not completely consumed in use, as well as plutonium, reprocessing of fuel has been a much more active issue elsewhere.

Used fuel elements are now being stored under water at Canadian nuclear plants. About fifteen years of generating station experience

are now available with this type of storage and it has been proven safe and reliable. Since nuclear energy produces less than one pound of waste for every twenty tons from a comparable coal-fired plant, the nuclear wastes produced in Canada are small in volume. All the irradiated fuel produced to date has a total

cont. on page 2

The CANDU Achievement
cont. from page 1

volume of 700 cubic metres, or that of a fairly large room. Canada's accumulated spent fuel up to the year 2000 would cover a football field to a depth of about 4 feet.

Two concepts can be applied to the management of nuclear wastes — **storage** and **disposal**. In Canada the philosophy has been to store irradiated fuel until a decision on its ultimate disposition is necessary or desirable. **Storage** implies an intent to retrieve the material at some time in the future. It is recognized that the reprocessing of CANDU fuel would recover valuable fissionable materials that may become important should there be any shortage of uranium in the next century. The plutonium in spent CANDU fuel, by the year 2000, will be equivalent in energy potential to Canada's oil reserves excluding the tar sands.

Disposal implies that there is no intent to retrieve the material and that it will be isolated so that eventually there will be no need for human intervention.

It is expected that the management of irradiated fuel over the next twenty years or more will continue to be centered on storage. For the next few years all storage will be in water-filled bays of the generating stations. The water-cooled pool concept is also being evaluated for large-scale storage of fuel at central sites. Other concepts for dry storage of irradiated fuel are being evaluated, developed and demonstrated.

Although these engineered facilities are adequate for storage for periods of fifty years or so, it is generally agreed that the radioactive wastes should eventually be immobilized in an insoluble matrix and buried deep in dry stable geological formations to isolate them from man's environment as long as they are hazardous. There is international consensus that this is one of the most secure methods for permanent

fixed in the soil of the controlled area could be used for permanent storage of such wastes from fifty 600-MW CANDU reactors.

The objective of the Canadian waste management program, therefore, is to provide safe storage of spent fuel until society determines whether the potential energy it contains should be exploited through reprocessing of the fuel elements. But regardless of the outcome, spent fuel or the products of its reprocessing can be safely stored until its activity has declined to safe levels. Canada is presently participating in a seven-nation International Nuclear Fuel Cycle Evaluation (INFCE), to review fuel cycle options and methods of ensuring against nuclear weapons proliferation, while enabling the benefits of fuel recycling, which are especially desired by countries not endowed with Canada's large uranium reserves.

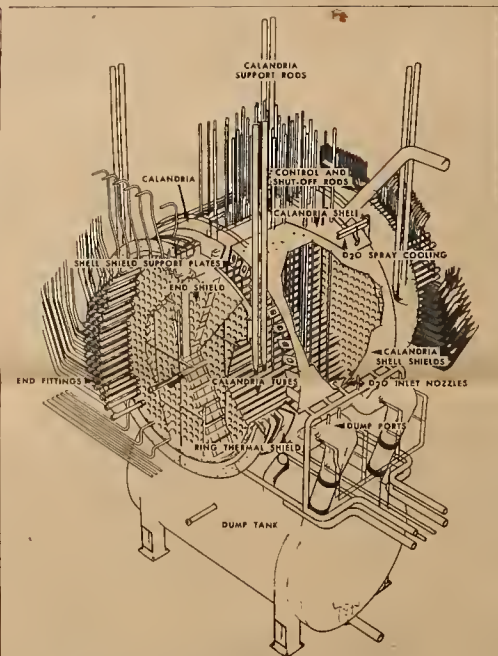
AECL is proceeding with a program to develop and demonstrate the technology for the disposal of radioactive waste so that the potential hazards of the material are negligible and so that they will be of no concern to future generations. Immobilization of the fuel or waste is the first step to achieving these objectives. Active wastes could be permanently stored in blocks of a glassy silicioous material, which would then be deposited deep underground in the geological repository. In a pilot project during the 1960's, 50 of such blocks were buried in loose sand on the grounds of the Chalk River Nuclear Laboratories. Even in contact with ground water, tests show that the blocks are dissolving more slowly than the radiochemicals themselves are decaying. The results of the Chalk River experiment indicate that, as far as leaching of radioactivity is concerned, burial of radioactive wastes

disposal of wastes. Nature had demonstrated that such a method would ensure that the wastes remain isolated for as long as they are potentially harmful.

RESEARCH BACKUP

The continuing activity of AECL in R & D assures improved performance and economics. Considerable work has been done on alternative coolant schemes — the Gentilly-1 reactor in Quebec demonstrated the feasibility of light water cooling, and the WR-1 reactor

of Whiteshell demonstrates the feasibility of cooling the CANDU reactor with an organic liquid which would allow higher levels of thermodynamic efficiency. However, the excellent performance of existing CANDU plants is likely to make utilities reluctant to change from heavy water coolant for many years.



Pickering Generating Station Reactor Assembly

the CANNON

Associate Editors: Dono Williams, Rob Pupulin, Peter Rankin

Press: Eric Hasking, Craigie Stevenson

the CANNON is supported by the Engineering Society. It is run by the students in the faculty of Engineering with the intent of providing the students in Engineering with an interesting and informative newspaper. All those who would like to help with your paper are welcome to. Submissions to the CANNON are also welcomed. They should be typed. The editors reserve the right to edit letters. The office of the CANNON is located on the Third Floor, Old metro Library, 20 St. George ST., Toronto, Ontario, M5S 2E4.

Gentlemen:

I would like to commend you and the Engineering Society on the new publication, "the Cannon". It is an excellent idea and much needed in a Faculty as large and diversified as Applied Science and Engineering.

The first issue shows promise of a successful newspaper. The articles were interesting, informative, and well-written. Your comments were well-stated and so very true! My job with Bell Canada has brought me into contact with various people in the last two years and I've found the majority of them lacking in a general knowledge of technology. Some of the contractors I visit on job sites are dumb-founded when they learn that a phone cannot be installed immediately because there is no cable in the vicinity to hook up to. They are not aware that it takes at least a week for me to design a cable system and a month or so for construction. They are sure that "phones work on air waves". That is just one example that come to mind when I read your article.

I wish you and the Engineering Society the best of luck on "the Cannon" and for a very successful year!

Sincerely,

Morto Ecsdi-Conquergood
1976 President of the Engineering Society

Sneaky pete,
Lost Years'



Dear Friends,

In case you didn't quite get the drift of the last Diversions column, ie you don't know, even now, how to chose a suitable pattern to start LIFE, here goes.

All you do is chose a number of beings in ANY pattern that you want. Simple.

Your friend,

Bromer

Here ogoin is a list of those helping with the yearbook so far...really now, wouldn't it be great to be a part of what used to be one of your greatest concerns? It is a lot of fun...honest...please!!!

the other systems require the waste to be burned for immediate use as heat or generating power.

COMPACT COMBUSTION

This system burns waste in a fluidized bed combustor and the hot gases are used to drive a turbine for electricity generation; the advantages being that these stations are compact, occupying less than 8,100 square metres of land, and could be located at many satellite points throughout a city. Again, this is an untried alternative and start-up costs can be made only from a manufacturer's estimate, thus are not totally unbiased.

Energy from solid waste is a viable and economic alternative and it is worth exploring. There is no question that with land fill sites becoming more remote, and the cost of fossil fuels rising exponentially, this option will become more and more favorable.

PYROLYSIS

This method of energy recovery is a destructive distillation of solid waste in an oxygen-free environment. "The organic portion of the refuse can be converted into gas, liquid, and inert char. The gas and liquid portions can be converted into energy ... but this system ... is as yet unproven ... results released to date are sketchy and inconclusive." A laboratory study performed by the US Bureau of Mines showed that the process could provide enough energy to run itself and still provide extra energy for external uses.

This process is still in the study stage. Start-up costs of two prototypes have been much higher than expected, but this is not unusual with "new technology" systems. With time, the system will be debugged and running economically. It is worthwhile to mention here that this system produces fuel which can be stored or used in conventional systems, whereas

Solid Waste Management

cont. from page 1

developed in St. Louis uses treated solid wastes as a supplement to coal. The waste is passed through a hommermill to shred it into finer material. It is then fed into an air density separator which separates the light combustible material from the heavy fraction. This heavy material is then subjected to a series of magnetic separators to remove ferrous materials from the non-magnetic heavy residue for recycling and disposal. The light material is stored until required for use with the coal.

This process implies a cost of about (US) \$4 per tonne in 1974. Even with lower heat recovery than coal, one tonne equivalent would cost (US) \$8. It is obvious that waste heat recovery is economically feasible when compared with the \$37 now paid.

cont. from page 2

OTHER PROVINCES

It was logical that Ontario, with a population of eight million; a concentration of heavy industry, and few undeveloped energy resources except uranium, should have been the first Canadian province to adopt nuclear power.

However, other provinces, as the cost of alternative fuels for electric generation have climbed, are also turning to nuclear power. Quebec is building a 600 MW single CANDU nuclear electric unit at Gentilly, adjoining the site of an earlier experimental 250 MW (e) power plant.

A similar 600 MW CANDU-PHW unit is being built for the New Brunswick Electric Power Commission, at Point Lepreau on the shore of the Bay of Fundy, also for completion in 1980.

Canada's nuclear enterprise involves other provinces as well. Nova Scotia's Cape Breton Island is the site of two heavy water plants, one at Port Hawkesbury, originally built by Canadian General Electric Limited but now operated by AECL, and a plant at Glace Bay, originally built in the 1960s by the Government of Nova Scotia but now completely rebuilt by AECL and back in production.

Manitoba too has an essential part of Canada's nuclear effort at Whiteshell Nuclear Research Laboratories, where important work has been done in developing an experimental organic cooled reactor, and where Canada's research into disposal of reactor wastes is now centered.

In fact, with the high proportion of Canadian content in

each nuclear station, there is not a province in Canada that has not provided some resource for Canada's nuclear effort. This will increase, with the size of this program. As fossil fuel supplies dwindle and hydro sources become developed, various provinces will be seriously evaluating the nuclear option. In a recent address to the Canadian Community Newspapers Association, Robert Bonner, British Columbia Hydro chairman, stated that major nuclear development is unavoidable in Canada. He added: "The exotic alternatives so dear to the

tion of other countries as soon as NPD began operating successfully in the 1960s. The CANDU technology was seen as uniquely appropriate for countries of intermediate industrial and economic capability, with their own supplies of mineable uranium, who desired a nuclear power program not tied to the import of fissionable material from on of the great powers. Producing heavy water is simpler than enriching uranium. It is also required only one in a reactor's lifetime (except for small quantities to make up for losses), as opposed to a continuing requirement for enriched fuel.

Canada is presently supplying engineering, materials and equipment for two other stations, of 600 MW (e) unit size, one in the state of Cordoba, Argentina, and one at Wolsung, on the east coast of the Republic of Korea.

While trade in nuclear power plant and technology has been criticized because a universal concern about proliferation of nuclear weapons, it has remained Canadian policy to disseminate the benefits of the peaceful uses of atomic energy. However, Canada has made the observance of nuclear safeguards a condition of all exports of nuclear equipment, technology, or fuel materials.

Another thrust of AECL research is to develop potential improvements on the CANDU fuel cycle. The good neutron economy of CANDU permits the exploitation of thorium, an element three times as common as uranium. Utilization of thorium in CANDU would transform it into U-233, a fissionable isotope of uranium. By reprocessing the spent fuel, such a cycle could be built up so that, at equilibrium, it would breed most of its own fissionable fuel, requiring only small additions of thorium into the cycle, and no more uranium. This is considered by many a superior strategy to the use of plutonium-fuelled "breeder" reactors, now being developed in the U.S. and Europe. However, as said earlier, the decision on fuel reprocessing must first be made.

THE FUTURE

Ontario is continuing its program of four reactor generating stations, at Pickering "8", Bruce "B", and Darlington which will more than double Ontario Hydro's nuclear capacity by the late 80s. Engineering studies are being carried out for a 1250 MW (e) unit which, if adopted

by Ontario Hydro, would also be built in a four-unit station. It is estimated that by the end of the century there will be about 100 nuclear electric generating units across Canada, with a total capacity of about 80,000 MW (e) — equivalent to Canada's total electric generation capacity at present.

THE CANDU ACHIEVEMENT

The CANDU achievement over the past 20 years has been based on a unique pattern of co-operation between utilities, government agencies, and the private manufacturing sector. The CANDU reactor has a solid and unsurpassed record of safe and cost-effective operation. The total development cost of the CANDU system, including demonstration and prototype reactors, is estimated at between one and two billion dollars (depending upon what items are included as development expense). This is roughly comparable to what has already been spent in the U.S.A. on a single reactor concept — the fast "breeder" — which has to date produced no useful power.

The U.K. and France have already admitted that reactors built according to their original national concepts are obsolescent, and are turning to U.S. style light water reactors, which other European countries and Japan already employ.

It may be considered then, that the U.S. and Canada have the only two national nuclear programs which have stood the test of time.

The CANDU program is a monument to the dedication and skill of Canadian scientists, government leaders, and industrial and utility management. It will continue to be a major component of the world's effort to increase the application of nuclear energy in the service of man.

Committed and Planned Canadian Nuclear Power Stations

Station	Unit	Unit Rating MW(e) net	Power System	First Operation
NPD	1	22	O.H. ¹	1962
Douglas Point	1	208	O.H.	1966
Pickering 'A'	4 x	514	O.H.	1971-73
Gentilly-1	1	250	H.Q. ²	1971
Bruce 'A'	4 x	750	O.H.	1976-79
Gentilly-2	1	600	H.Q.	1980
Lepreau	1	600	NBEPC ³	1980
Pickering 'B'	4 x	514	O.H.	1981-83
Bruce 'B'	4 x	750	O.H.	1983-86
Darlington	4 x	800	O.H.	1986-88
unnamed	1	600	M.H. ⁴	1985+

1. O.H. — Ontario Hydro
2. H.Q. — Hydro Quebec
3. NBEPC — New Brunswick Electric Power Commission
4. M.H. — Manitoba Hydro

hearts of protesters and writers of popular articles can not make a serious impact upon the energy supply problems for at least ten years.

EXPORTS

The development of the CANDU system attracted the atten-

A nuclear station of 125 MW (e) capacity was completed at Karachi, Pakistan by Canadian General Electric in 1971, while AECL assisted the Indian Atomic Energy Commission to build a station of 200 MW (e) capacity in Rajasthan, RAPP-1, which went on-power in 1972. India is presently building five more stations similar to RAPP with her own resources.

Environmental Impact

cont. from page 1

The release of pressure behind the shock wave resulted in the fusion of material shocked to pressures in excess of 600 kilobars, forming a roughly hemispherical volume with a diameter of about 10 kilometers. This melt zone graded into and was surrounded by a zone that had been shocked to pressures of between 200 and 600 kilobars and heated to temperatures of only a few hundred degrees Celsius. Still farther out, in response to shock pressures of less than 200 kilobars, the rock was intensely fractured.

Besides adding internal energy to the rocks by heating, fracturing and melting them, the shock wave transmitted the meteorite's momentum to the earth, propelling material generally downward and outward in a spherical pattern centered on a point a kilometer or so below the surface under the impact point. The melted material near the

centre was accelerated to a speed of more than three kilometers per second.

The next stage of the cratering process involved the flow of melt and rock in dissipating their momentum and internal energy after the first few seconds of the passage of the shock wave. At first the debris flowed downward and outward more or less equally, but the compressibility limit of the bottom was soon reached and the flow became predominantly outward. Eventually the melt flowed far enough radially to form a "lining" on the less shocked materials at the edge of the cavity. At the bottom rocks subjected to peak pressures in the 200-to-400-kilobar range remained in place, whereas the sides of the excavation rocks fractured by pressures of less than 50 kilobars were ejected.

The motions of the melt were initially extremely turbulent "owing to millimeter-scale velocity differences set up by the passage of the shock wave through different minerals in the target and to complex refraction and diffraction effects of larger-scale heterogeneities in the target. In addition, the melt maintained a higher velocity than the less shocked material.

These effects set up complex motions that mixed less shocked material into the superheated melt." Blocks ranging up to tens of meters in size were incorporated, with the bulk of the material being in the submillimeter range. As

the outward-migration phase of the melt was "at most a few minutes."

The members of the Manicouagan study group responsible for analyzing the petrogenesis of the melt sheet estimate that it took roughly



the melt approached the edge of the cavity, it incorporated less shocked clasts: bodies at temperatures lower than 100 degrees C. The remnants of these clasts were preserved and can be seen today in the rock samples. The time required for the completion of

100 seconds for the melt to reach thermal equilibrium with the last batch of cold clasts. This final quenching of the clast-melt mixture triggered the crystallization phase "possibly by purely thermal effects but also possibly by nucleating plagioclase ...

directly on undigested remnants of clasts." Thereafter the viscosity of the melt increased rapidly "because large blocks, some tens of meters across, did not sink or float." During this period the bottom of the cavity was rising and the margins of the excavation were slumping; these motions apparently took place while the melt was still fluid enough to flow around breaks in the basement.

The investigators reckon that 1,600 more years were required to complete the crystallization of the melt sheet at Manicouagan. The crystallization front moved in from the sides of the crater, reaching a distance of 10 meters in about 35 years. During the final cooling phase the melt was "apparently prevented from convecting by the rapidly nucleated crystals."

"The chemical, isotopic and thermal-balance studies on the Manicouagan melt rocks amply illustrate some of the processes of impact melting. These studies and the geophysical and structural data from Manicouagan have provided constraints and models of the impact process that can be used and tested in further investigations at other craters and on other planetary surfaces." *Scientific American*

WE HAVE A FEW QUESTIONS:

- (1) Have you recently read any interesting engineering-related articles in magazines, journals, etc.?
- (2) Are you writing a thesis?
- (3) Do you know any engineers?
- (4) Do you have any special engineering-related hobbies or interests?

If you answered "yes" to any of the above questions, we're counting on you to write for the Cannon.

The Cannon needs articles for all departments - from major illustrated technical reports to short Diversions. So if you have anything of interest to other Engineers, let us know. The Cannon is your paper - your participation will guarantee its success.

The Cannon is distributed on Thursdays, whenever the Toke isn't. Deadline for copy is 5:00 PM Monday. Articles should be typed. The Cannon offices are on the third floor of the old Metro Library, across the aisle from the stores.

FIROSH

BT2

If your F!rsh card is stamped with all the appropriate stamps, for Orientation as outlined in your Frosh Kit, you are entitled to a FREE U of T Engineering

T-SHIRT

Present yourself at the Stores on or after Tuesday, October 10 with your card.

ATTENTION ALL COMMITTEE ORGANIZATION AND CLUB CHAIRMEN

The Cannon is a publication that is designed to keep all of our Engineering faculty informed as to the goings on around Campus. Since the vast majority of the student population in our faculty don't know the full extent of or even the purpose of various organizations, clubs and committees, the Cannon would be an ideal way to publicize the activities and events that will occur.

As well as this, all relevant committee and club internal affairs can be reported on within these pages.

Accordingly, anyone wishing to submit interesting articles relevant to the above is welcome to, as this would be greatly appreciated by the entire student body.

All submissions should be put in the Cannon Mailbox no later than the Monday before publication.

ENGINEERS!**START PLANNING****NOW FOR SUMMER JOBS IN '79**

1. Check Placement Centre bulletin boards from early October so as not to miss out on opportunities with large national employers recruiting on campus

2. Be prepared - attend our resume and interview seminars offered regularly during the school year. Success in job hunting isn't all luck!

3. Start planning your own job search. Our Career Library contains many employer directories and lists by discipline of companies that have advertised summer jobs with us in the past.

GET A HEAD START AND ACT NOW!!

Career Counselling & Placement Centre
344 Bloor St. W., 4th Floor
(just west of Spadina)

BLUE AND GOLD

COMMITTEE MEETING - 5 P.M. -

THURSDAY OCTOBER 5th in the STORES

RESUME & INTERVIEW PREPARATION

Thursday, October 5
5-7 P.M.

Sidney Smith Rm. 2135

guest employer/lecturer:

Mr. B. Watson
DOFASCO

DIVERSIONS

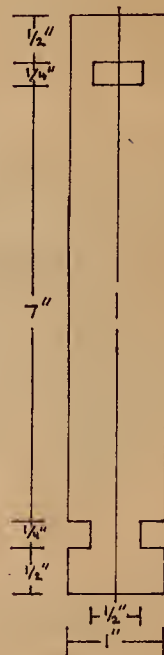
by Bramer Kgnort

Should you be faced with another dull tutorial in a room on the north side of the Galbraith building or facing into the court yard of the same building, take heart! Working from either the third or fourth floor, it is possible to launch an airplane (paper of course) into some of the best updrafts on campus. Naturally the kind of airplane required to take advantage of these updrafts will not be your average paper dart style. Something with a large surface area to weight ratio is needed. I suggest two such designs:

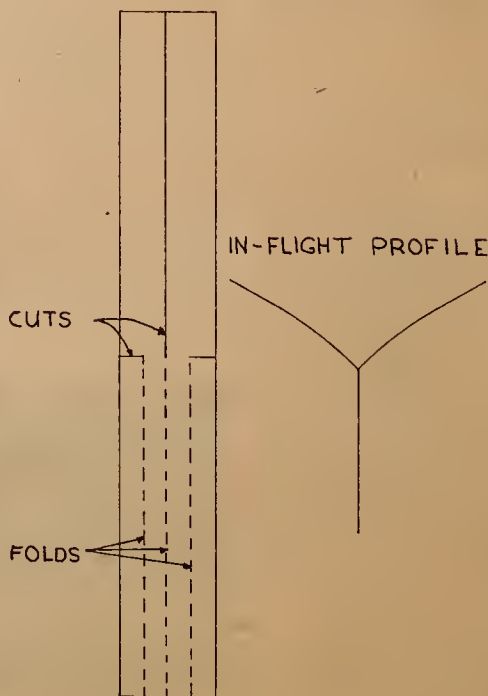
The first starts with a strip of paper about an inch wide, and eight and a half inches long (a convenient length). Fold the strip in half and remove a notch about a quarter inch square, half an inch from each end. The notches have to be on opposite sides of the strip to produce a hole in the unfolded strip at one end and a tee shape at the other. Push the tee through the hole and spread the paper out to its full width. Viewed from the papers edge the result should look similar to the outline of a fish. Upon launching this 'plane' see that it is spinning around an axis through the "tail" and the "head" in order to give it in-flight stability. If the winds are right the results will be impressive. Some even manage to make it across St. George much to the surprise of unwary food vendors.

FISH PLANE

NOT TO SCALE

**ASSEMBLED PROFILE**

The second design is a

HELICOPTER

helicopter style that like the first, starts with a strip of paper 1 inch by 8 1/2 inches folded along the long axis. It is necessary to cut the fold from one end to a point one third of the way along the strip. At the end of this cut and perpendicular to it, it is necessary to make two cuts that extend from the outside edges of the unfolded paper one quarter of the strip width in. With these cuts made, it is possible to fold the paper at the uncut end of the strip on itself twice, the first fold wrapping the outside quarters on the inside quarters and the second fold bringing the remaining quarters in contact with each other. The loose unfolded strips at the cut-end form the propeller blades and must be folded to hang slightly elevated from perpendicular to the body of the helicopter when it is in flight (test this with a few trial flights). To start them in flight these helicopters are just dropped after which the blades will start spinning. Spinning slows the rate of descent of the helicopter and in the slightest updraft the rate becomes negative. In fact these rather fragile contraptions have been known to stay in flight for extended periods (over three minutes in this author's experience). Story has it that one unusually well designed model was seen flying over Convocation Hall in the direction of Queen's Park. Wouldn't Bill Davis be surprised to learn that in spite of his government's cutbacks, Engineering is alive and well at U of T.

THE BLUES SECOND HOME GAME against the University of Windsor Lancers takes place this Saturday at 2:00 PM in Varsity Stadium. Student Admission is \$1.50. See you at the game!